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Machine Learning Techniques for Traffic Rules Violation using CC TV

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ABSTRACT

Using computer vision techniques, Traffic Rules Violation Detection with Computer Vision aims to automate the process of detecting traffic violations. The system uses CCTV camera footage to detect and monitor vehicles, and to identify traffic violations such as signal violation, parking violation, and wrong-way violation. The initiative also incorporates an intuitive graphical user interface (GUI) that enables users to monitor traffic footage, receive alerts about violations, and take appropriate action. OpenCV is used for image processing and computer vision duties during the implementation of the project, while TensorFlow is used for training the vehicle classification model. Using the PyQt5 library, the graphical user interface allows users to administer cameras, view violation records, add cars and rules, search for vehicles, and more. Additionally, the GUI provides visual representations of cameras and detected violations, making it simpler to monitor and analyse the detected violations.

Kewywords: **Traffic Violation,**

1. INTRODUCTION

The increasing number of automobiles in urban areas can lead to an increase in traffic volume, which means that traffic violations are becoming increasingly serious in Bangladesh and around the globe. This results in severe property damage and additional accidents that may imperil the lives of the people. Traffic violation detection systems are required to address the alarming problem and prevent such catastrophic outcomes. Therefore, the system constantly enforces appropriate traffic regulations and apprehends those who do not comply. As authorities constantly monitor the highways, a traffic violation detection system must be implemented in real-time. Therefore, traffic enforcers will not only be able to implement secure roads accurately and efficiently, but also with greater ease, as the traffic detection system detects violations more quickly than humans.

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This system can detect the three most common categories of traffic violations, namely signal violation, parking violation, and wrong direction violation, in real time. A user-friendly graphical interface is associated with the system to make it easy for the user to operate the system, monitor traffic, and respond to traffic rule violations.

The rise in the number of vehicles on the road has caused an increase in traffic congestion and a rise in traffic rule violations. These violations not only impede traffic flow, but also pose a serious threat to public safety. To address this issue, automated systems that can detect and monitor traffic rule violations in real-time are required.

Traffic Rules Violation Detection with Computer Vision is an initiative that employs advanced computer vision techniques to combat the problem of traffic violations. The system employs CCTV camera footage and image processing algorithms to identify and monitor vehicles on roadways. By analysing the behaviour of vehicles, the system can identify a variety of violations, including signal violations, parking violations, and wrong-way violations.

This project's primary objective is to automate the process of traffic rule enforcement and provide authorities with a dependable and effective solution for monitoring and addressing violations. By utilising computer vision technologies, the system is able to accurately detect infractions and collect pertinent evidence for further action. This not only reduces the workload of human traffic enforcers, but also ensures a more objective and consistent enforcement of traffic laws.

In addition to detection capabilities, the project includes an intuitive graphical user interface (GUI) that enables users, such as traffic police officers, to easily monitor traffic footage, receive real-time notifications about violations, and manage recorded data. The graphical user interface provides a comprehensive view of detected violations, allowing users to access detailed information, images, and associated data for each violation case.

This project seeks to increase road safety, improve traffic management, and facilitate more effective enforcement of traffic regulations by automating the process of detecting violations of traffic laws. It

functions as a demonstration of how computer vision technologies can be applied to real-world problems and contribute to safer, more organised road environments.

Due to the ever-increasing number of vehicles on the roadways, enforcing traffic regulations has become a priority for public safety and effective traffic management. Monitoring traffic violations manually is a difficult and resource-intensive endeavour. Automated systems employing computer vision techniques have emerged as a promising solution for overcoming these limitations.

Using CCTV camera footage, the Traffic Rules Violation Detection with Computer Vision project seeks to develop a comprehensive system capable of detecting and identifying traffic violations in real-time. Utilising advanced image processing algorithms and machine learning techniques, the system can precisely identify violations such as signal violations, parking violations, and wrong direction violations by analysing the behaviour of vehicles.

This project's primary objective is to automate the process of traffic rule enforcement in order to make it more efficient and dependable. Using computer vision technologies, the system can consistently monitor the roads, detect violations with high precision, and alert the appropriate authorities in a timely manner. This proactive approach not only aids in preventing accidents and traffic congestion, but also enables swift action against offenders.

The initiative includes an intuitive graphical user interface (GUI) to improve usability and accessibility. The graphical user interface enables traffic police officers or administrators to monitor live traffic footage, view alerts for violations, and administer recorded data. It provides a comprehensive overview of detected violations, including pertinent details, images, and associated data for effective decision-making and investigation.

This project contributes to establishing safer road environments, reducing human error in enforcement, and improving overall traffic management by automating the process of detecting violations of traffic rules. It functions as a practical demonstration of the ability of computer vision and artificial intelligence to address real-world problems and improve road safety.

Objective

The goal of the project is to automate the traffic rules violation detection system and make it ease for the traffic police department to monitor the traffic and take action against the violated vehicle owner in a fast and efficient way. Detecting and tracking the vehicle and their activities accurately is the main priority of the system.

LITERATURE SURVEY

The increasing number of cars in cities has led to a rise in traffic congestion and an increase in traffic violations worldwide, including in Bangladesh. Traffic violations not only disrupt the flow of traffic but also pose serious risks to public safety, causing property damage and endangering lives. To address this critical issue and prevent potential consequences, the implementation of automated traffic violation detection systems has become necessary. These systems enforce traffic regulations in real-time and aid in the apprehension of violators. By utilizing advanced technologies, such as computer vision and machine learning, these systems can detect violations more efficiently and accurately than human operators. This literature review aims to explore the significance of automated traffic violation detection systems, their capabilities, and the benefits they offer in terms of improving road safety and traffic management.

Importance of Automated Traffic Violation Detection Systems:

The importance of automated traffic violation detection systems in maintaining road safety and order cannot be overstated. These systems offer numerous advantages over manual enforcement techniques. First, they operate in real-time, monitoring road conditions continuously and detecting violations as they occur. This instantaneous detection facilitates prompt response and enforcement actions.

Second, automated systems ensure uniform enforcement across multiple locations and time periods. Automated systems utilise standardised algorithms to ensure uniformity in enforcement, in contrast to human operators whose ability to identify violations may vary. This consistency contributes to the establishment of a reliable and equitable traffic management system.

Capabilities of Automated Traffic Violation Detection Systems:

Automated traffic violation detection systems use a number of different technologies to find and keep track of breaches. One important technology is computer vision, which lets people look at surveillance camera video to find certain kinds of violations. By using image processing methods like grayscaling, blurring, background subtraction, binary thresholding, and contour analysis, these systems can find violations like not stopping at a signal, parking in the wrong place, or going the wrong way.

Also, methods for machine learning are used to train models that can classify vehicles, recognise licence plates, and look at patterns of how vehicles move. This lets the system correctly find and keep track of the vehicles that broke the rules. Using deep learning architectures like convolutional neural networks makes it easier for the system to handle complicated traffic situations and get more accurate results.

Benefits of Automated Traffic Violation Detection Systems:

Automated traffic violation recognition systems are good for both the police and the people who use the roads. First of all, these methods make roads safer by discouraging people who might break the rules and encouraging people to follow them. Knowing that violations are being constantly watched and punished is a deterrent, so people are less likely to drive recklessly.

Second, automated systems take some of the work off of human traffic enforcers, so they can do other important things like respond to accidents and handle traffic. By automating the process of finding violations, these systems make operations more efficient and lower the number of people needed to enforce the law.

Also, automated systems produce accurate and reliable data on traffic violations, which allows officials to look at patterns of violations, find problem areas, and make targeted changes. This data-driven approach makes traffic management tactics more effective and helps people make decisions based on facts.

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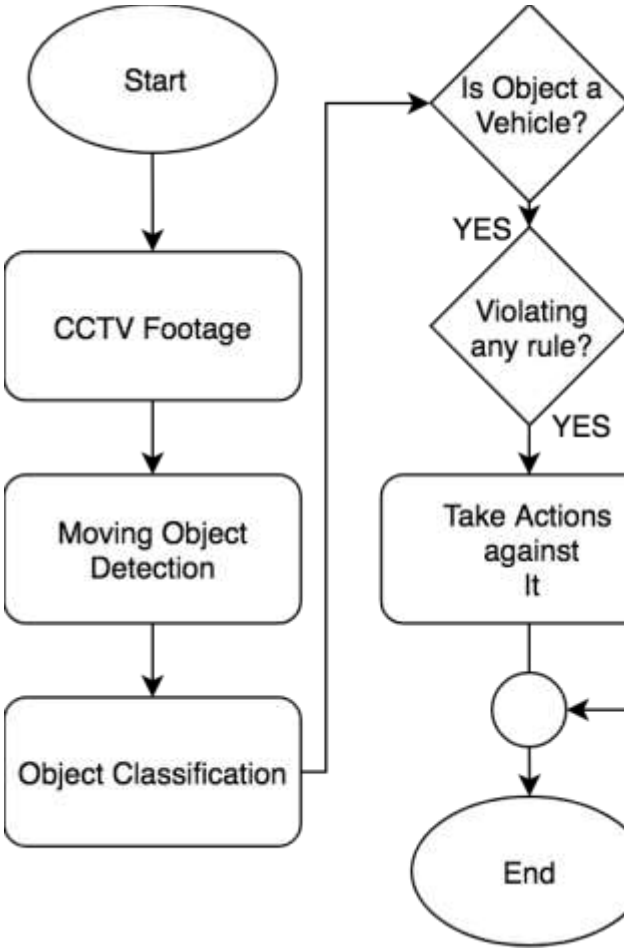
Methodology

The objective of the project titled "Traffic Rules Violation Detection with Computer

Vision" is to develop a comprehensive system capable of detecting and identifying traffic violations in real-time using CCTV camera footage. Utilising sophisticated image processing algorithms and machine learning techniques, the system is able to analyse vehicle behaviour and precisely identify violations such as signal violations, parking violations, and wrong direction violations.This project's primary objective is to automate the procedure for enforcing traffic laws so that it is more reliable and efficient. Because it employs computer vision technology, the system is able to keep a close eye on the roads, identify violations with great accuracy, and send timely notifications to the appropriate authorities. This preventive strategy not only reduces the likelihood of accidents and traffic congestion, but also makes it simpler to take swift action against lawbreakers.To enhance the project's usability and accessibility, a user-friendly graphical user interface (GUI) has been incorporated. The graphical user interface allows traffic police officers and managers to administer recorded data, view alerts for traffic violations, and monitor live traffic footage. For the purpose of effective decision-making and future investigation, it provides a comprehensive summary of the infractions that have been discovered, replete with pertinent details, photos, and associated data.By automating the process of detecting violations of traffic regulations, this initiative contributes to the creation of safer road environments, the reduction of human error in the enforcement of traffic laws, and the improvement of overall traffic management. It functions as a demonstration of the ability of computer vision and artificial intelligence to solve real-world problems and improve road safety for the general population.



The System consists of two main components -

- Vehicle detection model and
- A graphical user interface (GUI)

First, the roadside CCTV camera footage is transmitted to the system. Vehicles are identified in the video footage. System activity monitoring determines whether or not a violation has occurred. Various categories of violations require distinct algorithms for determining the violation. A system flowchart 1 depicts the operation of the system. The Graphical User Interface (GUI) allows users to interact with the system. User is able to monitor traffic footage and receive violation alerts with captured vehicle images. The user can perform additional actions using the GUI.

Image Processing

1. ** Grayscaling and blurring ** As the part of preprocessing the input frame got from the CCTV footage, the image is grayscaled and blurred with Gaussian Blur method.

2. ** Background Subtraction ** Background subtraction method is used to subtract the current frame from the reference frame to get the desired object's area. equation (1) shows the method. dst(I) = saturate(|scr1(I) − scr2(I)|)
3. ** Binary Threshold ** Binarization method is used to remove all the holes and noises from the frame and get the desired object area accurately. equation (2) shows how the binary threshold works. dst(x, y) = maxVal if scr(x, y) > thresh else 0

4. ** Dilation and find the contour ** After getting the thresholded image,

it is dilated to fill the holes and the contour is found from the image. drawing rectangle box over the contours desired moving objects are taken.

Vehicle Classification

Extracting moving items from the preprocessed image. The objects in motion are categorised as cars, motorcycles, or other vehicles using a vehicle classification model. The mobilenet v1 neural network architecture was used to create the classifier model.

Type / Stride	Filter Shape	Input Size
Conv / s2	3 x 3 x 3 x 32	224 x 224 x 3
Conv dw / s1	3 x 3 x 32 dw	112 x 112 x 32
Conv / s1	1 x 1 x 32 x 64	112 x 112 x 32
Conv dw / s2	3 x 3 x 64 dw	112 x 112 x 64
Conv / s1	1 x 1 x 64 x 128	56 x 56 x 64
Conv dw / s1	3 x 3 x 128 dw	56 x 56 x 128
Conv / s1	1 x 1 x 128 x 128	56 x 56 x 128
Conv dw / s2	3 x 3 x 128 dw	56 x 56 x 128
Conv / s1	1 x 1 x 128 x 256	28 x 28 x 128
Conv dw / s1	3 x 3 x 256 dw	28 x 28 x 256
Conv / s1	1 x 1 x 256 x 256	28 x 28 x 256
Conv dw / s2	3 x 3 x 256 dw	28 x 28 x 256
Conv / s1	1 x 1 x 256 x 512	14 x 14 x 256
Conv dw / s1	3 x 3 x 512 dw	14 x 14 x 512
Conv / s1	1 x 1 x 512 x 512	14 x 14 x 512
Conv dw / s2	3 x 3 x 512 dw	14 x 14 x 512
Conv / s1	1 x 1 x 512 x 1024	7 x 7 x 512
Conv dw / s2	3 x 3 x 1024 dw	7 x 7 x 1024
Conv / s1	1 x 1 x 1024 x 1024	7 x 7 x 1024
Avg Pool / s1	Pool 7 x 7	7 x 7 x 1024
FC / s1	1024 x 1000	1 x 1 x 1024
Softmax / s1	Classifier	1 x 1 x 1000

Fig: MobileNet Body Architecture.

Parameter name	Value
learning rate	0.01
training steps	100

Fig-2: Trainninghyperparameters.

The model is trained using a transfer learning strategy using our dataset.Each category in the collection has 500 photos to work with. In table (2), we can see a breakdown of the training parameters.

Violation detection

Vehicle detection leads to three potential violations:

• Signal violation: this occurs when a vehicle crosses a defined line on the road when the light is red.

• Parking violations: if a car sits in a no-parking zone for too long, it is flagged as a violation.

• Tracking a vehicle's location might reveal if it is approaching from the wrong direction, known as a "direction violation." Current and historic coordinates are used to calculate the vehicle's heading.

Database Structure

We have used SQLite database with python to manage the whole data of our application. Here, in the relational database we have used BCNF of 5 tables. The tables are:

1. Cars
2. Rules
3. Cameras
4. Violations
5. Groups

Implementation

Image Processing and Computer Vision

Python's built-in image processing functionality is complemented by the OpenCV computer vision package. The Tensorflow machine learning framework is utilised to create the vehicle classifier.

The administrator must initially add a camera using the menu item for the project's initial use. The administrator can insert the camera's location and feed file into the system in this fashion. The camera module uploads the feed file to this location over the internet. To retrieve footage from the camera, we adopted a Linux file-sharing structure in which the camera sends a file to the server, which then uses that file to perform analysis and find any instances of illegal activity. The administrator can also record the X and Y coordinates (fig. 3) of

the camera's position. This is being done in preparation for when we try to utilise a map to find the cameras more quickly and easily. A JSON file containing the administrator's camera policies is also required. The camera can be used to detect wrong-way drivers, illegally parked cars, and other traffic infractions.

All of this is essential for getting the system up and running. Once the camera is installed, the software will immediately begin monitoring for infractions of traffic regulations. Then, the detection rules violations (fig. 4) will be populated when you open the camera by selecting it from the drop-down menu.

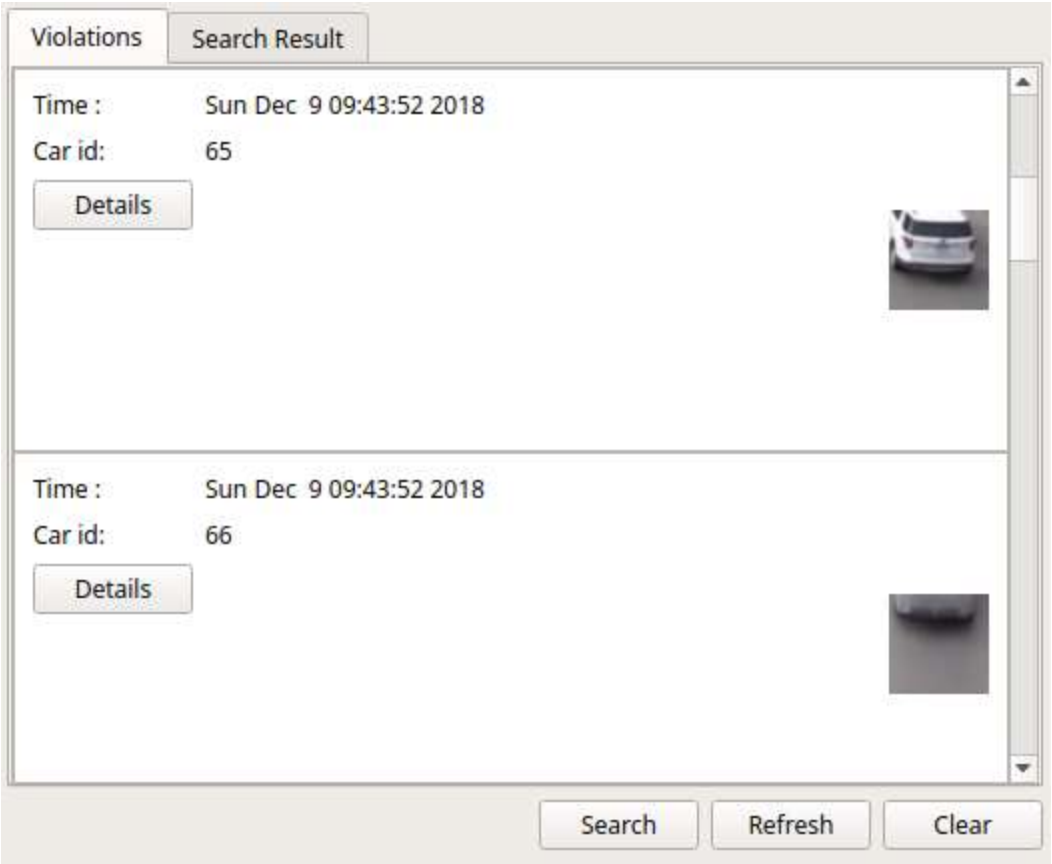


Figure 3: List view of violation records

The user has many other objects to insert into the database. The admin can add the following entities in the graphical user interface:

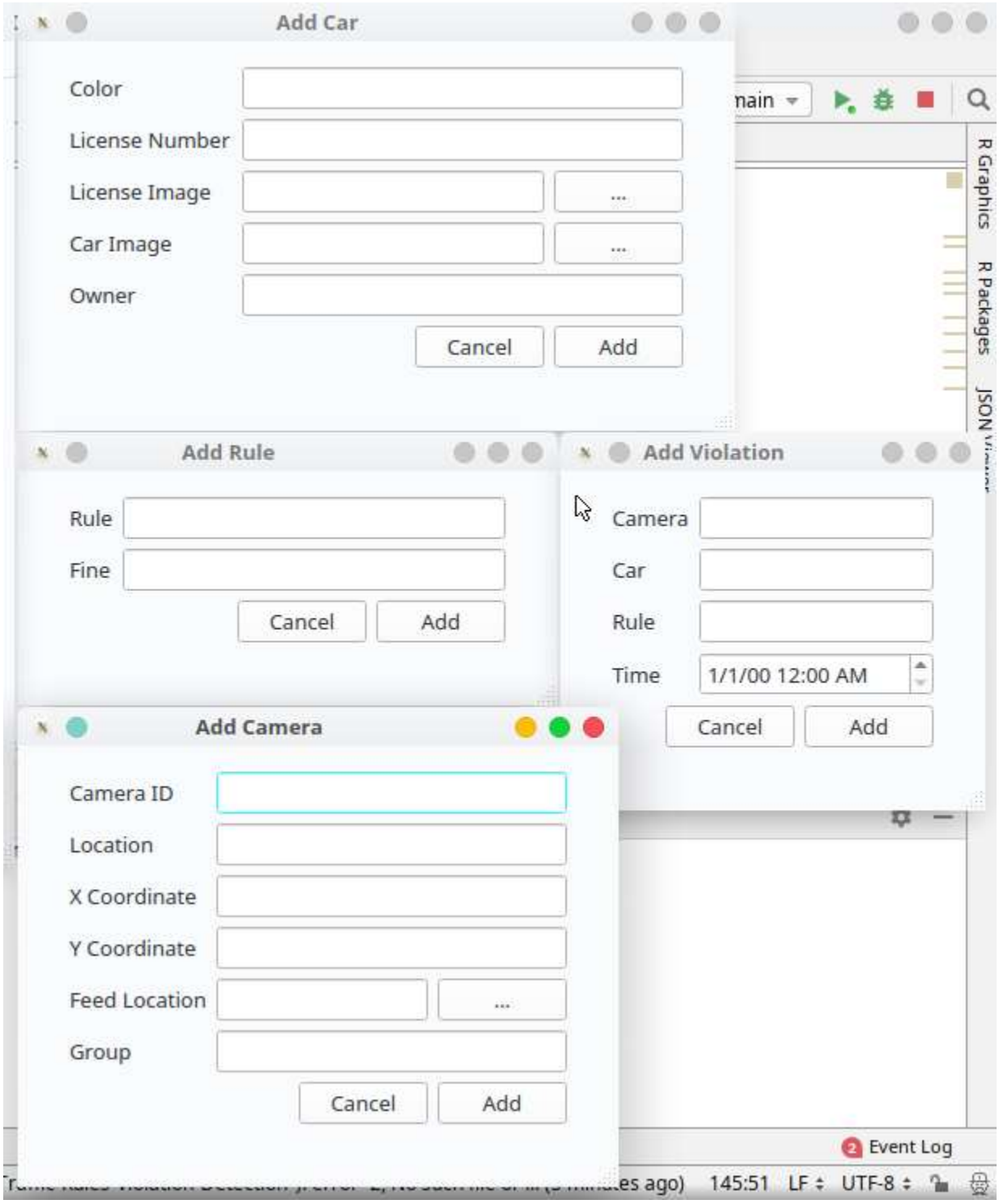
1. Camera (fig-3)
2. Car (fig-4)
3. Rule (fig-4)Violation (fig-5)
4. 

Figure 5: Adding items interface

The GUI is built on the idea that there will always be someone in charge of monitoring a set of cameras. He can view a list of infractions and further information on the vehicles involved (fig. 8). When he selects the detail button, a new window opens up where he can report the incident or send/print the ticket to the registered owner of the vehicle.

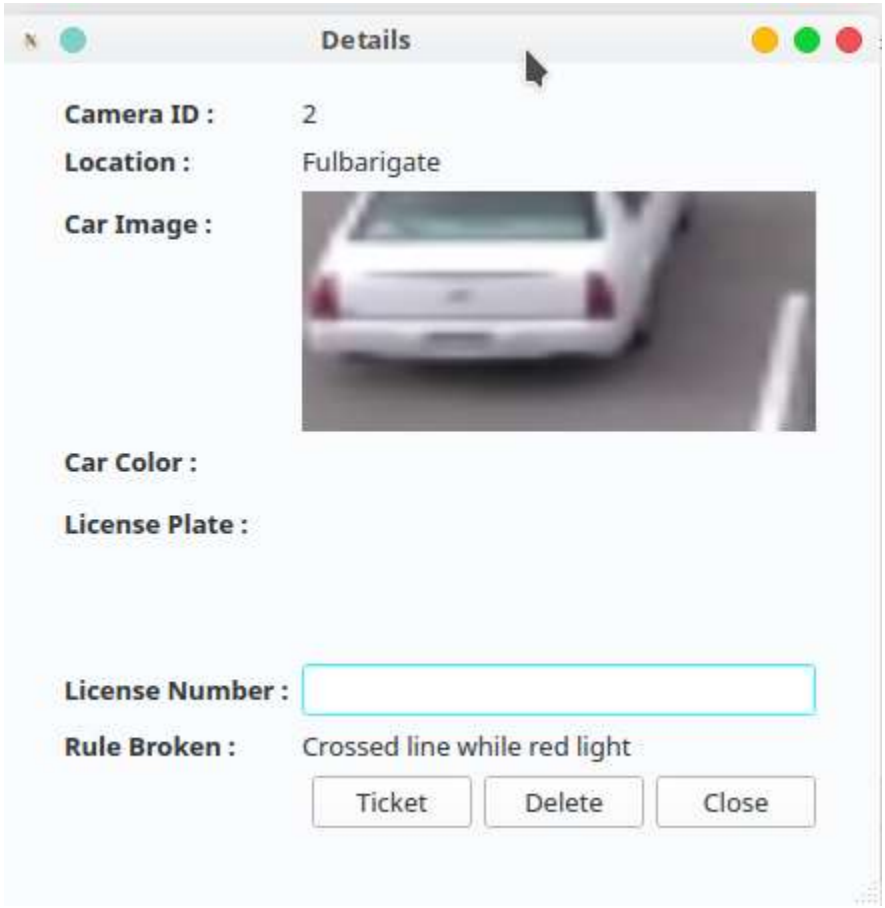


Figure 6: details of rule violation

If the administrator or user receives a false positive, he can simply remove the relevant entries. A record, however, will never be erased. A record of archived files is kept in the database. The administrator will need to use the archive window in order to restore a record from the trash bin. There, he can retrieve any archived file he want. Users can look up vehicles by number plate number, colour, or date of infraction. When entering a licence number, the user can utilise text prediction to verify that it is valid.

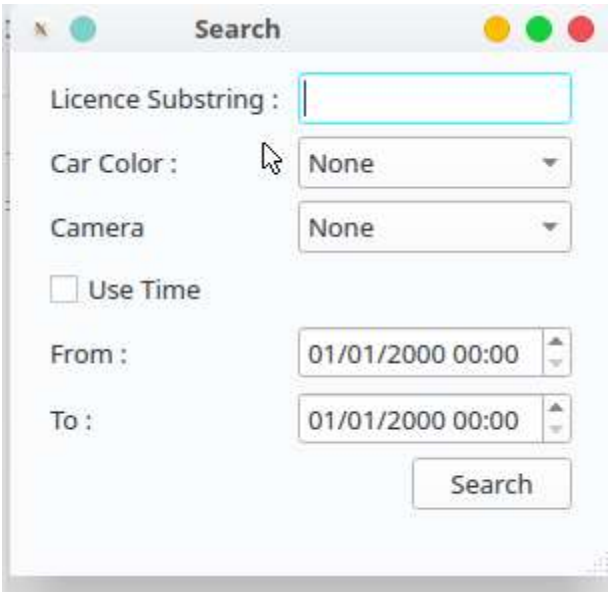


Figure 7: Searching a car or rule violation

Rules violation video representation in UI

There are currently 3 rules we are concerned with.

1. Signal Violation
2. Parking Violation
3. Direction Violation.

We've drawn a straight line to represent a broken signal. When the light turns red and a car crosses the centre line, the car's photo and some environmental data are stored in the system. The live preview shows the viewer exactly which vehicles are being monitored in real time to see if they are exceeding the speed limit.

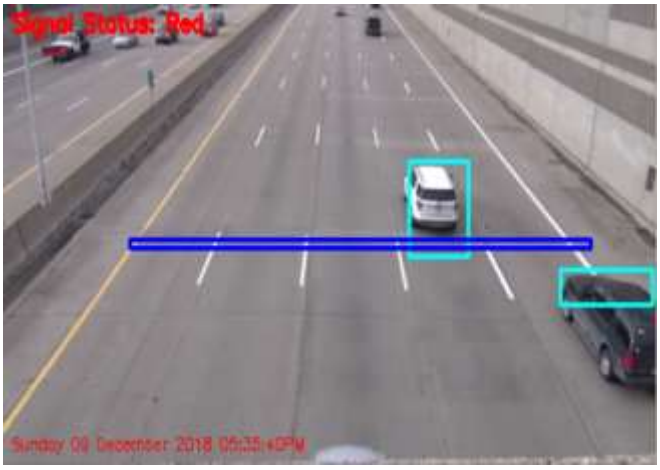


Figure 8: Signal violation camera representation

We have already pre-drawn a rectangle representing the parking zone's restrictions in case of a parking infringement. A picture with different environmental values is being added to the database whenever a vehicle has been in the rectangle for longer than a specified amount of time.

Figure 9: Parking violation camera representation

Lines are created to demarcate areas for the purpose of detecting direction violations. Then, the path that automobile takes from one area to another is tracked to determine its heading. Incorrect directions are recorded as having occurred in the past.

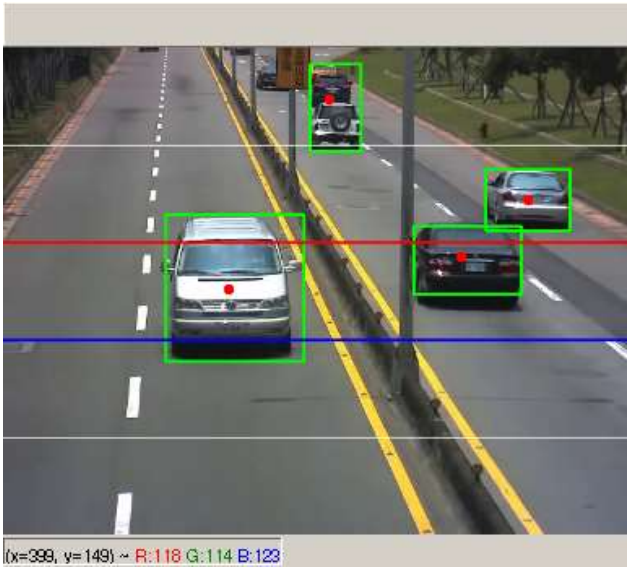


Figure 13: Direction violation camera representation

6. Conclusion:

For the purpose of automating the detection of traffic rule infractions using computer vision techniques, the Traffic Rules Violation Detection with Computer Vision project delivers a comprehensive solution. Signal violations, parking violations, and wrong-way driving are just some of the infractions that may be detected by the system in real time using image processing algorithms, vehicle categorization models, and violation detection algorithms. Because of the intuitive graphical user interface, traffic police personnel or administrators may easily monitor traffic, view notifications for violations, and manage the collected data.

The results of this work could have far-reaching effects on traffic management and law enforcement. Authorities can proactively address traffic offences by using automated detection systems, minimising the likelihood of accidents, congestion, and property damage. Because the system operates in real time, penalties for infractions may be applied instantly, guaranteeing that traffic laws are consistently and effectively enforced.

Future Enhancements:

While the current implementation of the Traffic Rules Violation Detection with Computer Vision project provides a solid foundation for automated violation detection, there are a number of enhancements and advancements that

could be made in the future: Classification of Fine-Grained Infractions: Increase the system's capacity to detect and categorise a wider variety of traffic violations, such as speeding, lane violations, and unlawful U-turns. This would necessitate training and the incorporation of additional machine learning models customised for each category of violation.

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